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Groundwater Quality Assessment in Amanishah Nala Environ of Jaipur City and Its Implications for Human Use

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Abstract

The paper attempts to assess the groundwater quality in and the vicinity of Amanishah Nala, once known as River Dravyavati that used to be the lifeline of Jaipur city. Having a fork pattern drainage with river Dhund, at the confluence zone of the river major part of Jaipur city is situated. The main objective of the study is to reveal the causes of depletion and degradation of the aquifer and its socio-economic and ecological implications. Secondary data have been used in the paper. The sources of data collection were Central Pollution Control Board (CPCB), Central Ground Water Board (CGWB), Jaipur Development Authority (JDA), Jaipur Municipal Corporation (JMC) etc. The paper reveals that the discharge of untreated industrial effluents and sewage into the nala has contributed considerable pollution in the groundwater in its vicinal areas and is harmful for use in agriculture and drinking purposes. The quality parameters have been compared with the drinking water standards laid by BIS and ICMR. Dyeing and printing industries, leather industries etc. are pouring untreated water into the nala and farmers are using it for irrigation. There is urgent need to set up Sewerage Treatment Plant(STPs), demolish illegal construction, check encroachment, restriction of civic amenities to illegal colonies etc. Moreover efforts to enhance the aestheticism around the nala, making od markets and construction of parking and parks for public can be developed after covering the nala. JMC, JDA, Forest Department, Agriculture Department should join their hands for concerted effort to preserve, conserve and augment this valuable resource, moreover people`s participation is inevitable.

Keywords: Groundwater, Aquifer, Nala, Dravyavati River, Food Chain, Health Hazards, Heavy Metals, Stps, JDA, Quality Parameters, Encroachment.

Introduction

Groundwater is, for many of us, an invisible resource. Because it is widely distributed in a range of water-producing geological structures (aquifers) and since it is much less dependent on recent precipitation than surface sources, it can provide a uniquely reliable source of high-quality water for human uses. While the links between the two sources of water may be intimate, the management of groundwater presents a separate and, arguably, more complex set of issues that relate to the spatial and temporal dimensions of its occurrence and the way societies and their economies organize themselves around its use. Hence, this paper concerns itself with groundwater management as a component of integrated water resource management. The advent and rapid spread of energized pumping technologies have enabled rapid groundwater development and the emergence of socio-economic systems dependent on its reliability. The development of groundwater continues to be predicated upon the perceived advantages of groundwater and the general assumption that the resource, as with surface-water systems,willbe replenishable or the reserves so great that one generation's impact will be insignificant. Development has, however, occurred without an adequate understanding of the complex and vulnerable nature of groundwater systems. Aquifer characteristics and groundwater flow properties vary laterally, vertically and temporally. These combine to create dynamic, interdependent systems that can be disrupted in unpredictable ways as a result of rapid development. What is remarkable is the rate at which aquifer systems have been depleted and degraded through over-abstraction and pollution. Unlike surface-water systems, much of this loss is irreversible and therefore much more critical. More importantly, development has occurred with little appreciation of how societies and economies organize themselves to take advantage of the opportunities groundwater presents and to respond to management needs as they emerge.

Review of Literature

Ray and Khangarot, (1989) reviewed the work on heavy metal pollution. They have discussed some of the heavy metals and their associated health hazards. Therefore it is desirable to treat such water to bring the level of heavy metals to acceptable limit before its use in irrigation.

Yammani (2007) Groundwater quality suitable zone identification with the application of GIS in Chittoor area, Andhra Pradesh, India The analytical results of the groundwater samples showed that the groundwater was alkaline.

Tatawat and Singh (2008) The hydro chemical investigation conducted was restricted to the major ions concentrations, distributions, their relative abundance and their pattern of the variability in groundwater chemistry. 11 ground water samples were collected from Jaipur City, Rajasthan, India from different hand pumps to study the chemical parameter, such as pH, EC, Total Hardness (TH), Ca, Mg, Na, K, CO_3, HCO_3, SO_4 and Cl with the help of standard methods of American public health associations (APHA) during premonsoon season (April 2006 to June 2006).

Kavita Batheja et al. (2007) The groundwater quality of Jaipur city experienced degradation due to rapid urbanization and industrialization. The impact of high concentration of TDS in groundwater used for drinking purpose with respect to medical norms was analysed).

Richa Marwari, Mayanka Kala and T.I. Khan (2009) have made attempt to find out concentration of heavy metals in the soil of agricultural fields in Amanishah Nalla in Sanganer town, and the heavy metal concentration in *Lycopersicon esculentum*. The vegetables here are grown in untreated water from municipal sewerage and effluents from textile industries.

The United Nations (2010) recognize access to drinking water and sanitation both as human rights and as prerequisites for the fulfillment of several other human rights.

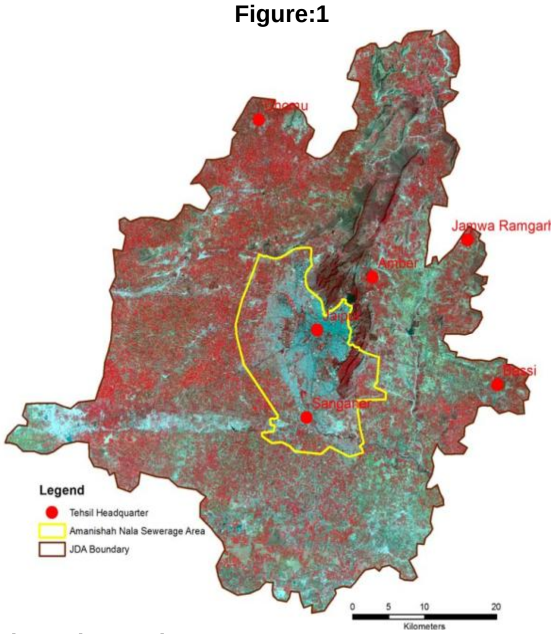
Van-Kinderen, I.; Vuik, R.; Pelgrim-Adams (2015) Demonstrated, four major hand-drilling techniques exist. These are augering, sludging, jetting and percussion.

WHO (2017) Water supplies must be physically accessible, sufficient in quantity, safe in terms of quality, available when needed, acceptable from the organoleptic standpoint, and affordable for everyone. While this ideal has been implemented in many industrialized countries, universal water access is yet to be achieved in many parts of the world, with rural areas significantly lagging behind [2]. This is often due to the absence of economic resources, technology and trained technicians, and generally represents a greater challenge in rural areas.

Grönwall, J.; Oduro-Kwarteng, S (2018) Domestic water demands are frequently estimated at 20 liters per person and day, although this figure can vary. One communal hand pump yields around 1 m3/h, so it is sufficient to meet the daily needs of 300 to 500 people. In general, securing access is the priority, while attention to water quality is more limited.

Study Area

Figure:1



About the Study Area

The Jaipur urban area lies between 26°47’ to 27°02’N north latitudes and 75°36’ to 75°55’E east longitudes located almost in the centre of the district and covers an area of about 470 km^2. Amanisha nala (Dravyavati River) is a life line of the city. It starts from foot hills of Nahrgarh (Athuni Kund) and flows through Jaipur city were in north to south direction and culminates in to Dhund River. The length of this nala is about 48 K.m. Many other nalas of the city i.e. Nahri Ka Naka nala, Ganda nala and Jawahar nala also merge with Amanisha nala. The Mazar Dam, Dam on sikar road, Goolar dam and Shri Ramchandrapura dam have been constructed on this nala. The water of Goolar dam and Shri Ramchandrapura dam is utilised for irrigation. Amanishah nalla shows Bank erosion in its upper reaches from Amer RF to Dahar Ka Balajee Railway Station and North West of Sodala. Bandi River shows bank erosion east and south of Kalwar. Amanishah nallah course has been obstructed throughout its course from north of Vidhyadhar Nagar to Goner by urbano-industrial development and agricultural activity in the nallaha bed. Amanishah nalla flows in the central part of the JDA region and has witnessed encroachments on its flood plain from its originating upper catchment area to its confluence with Dhund River South East of Goner.

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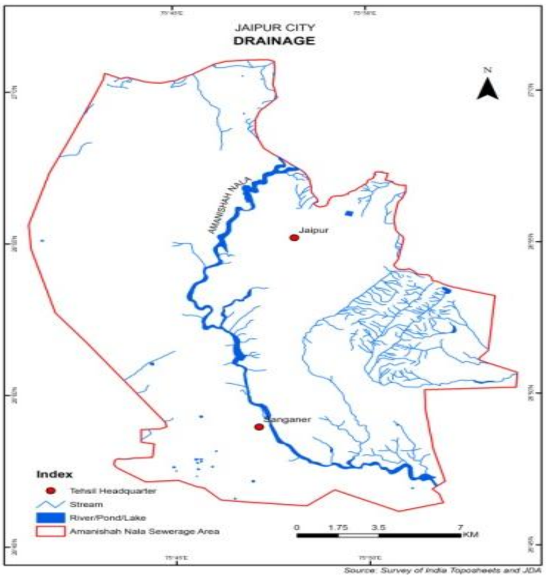
Figure: 2



Dhund river and *Amanishah Nala (Dravyavati River)* form a fork like drainage pattern in the convergence zone of which the major part of Jaipur city is situated. The Amanishah nala (Dravyavati River), which originates from the western slopes of Jaigarh hills, flows northwards in the upper riches, turns south and south-west in its middle course and flows towards east with a broad semi-circle. Finally it joins river Dhund further downstream.

Objectives of the Study

To assess groundwater quality of the study area and its utilization implications for human beings.

Data base and methodology:

Table:1

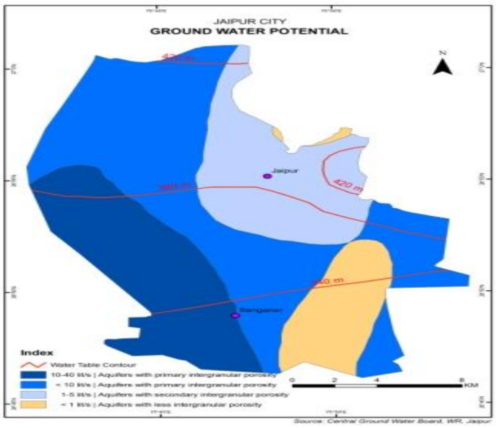
Secondary Information / data			
2	Published data of Govt. of India & Govt. of Rajasthan.	The Statistical Abstract (GOI & GOR)1981-2011	Spatial distribution of sites
2	Rajasthan Govt. Survey Report(GOI),2001,2011,2018	Govt. of Rajasthan	For geochemical and water depth analysis.
3.	Data records of the destinations. (Amanishah catchment)	Official Ward Centres.	For quantification of grim situation to humans, livestock etc and Significance.
	Structured no probability sampling method applied.		

A well structured survey in which no probability sampling method was incorporated Moreover was incorporated that involves the sample being drawn from the part of the population that is close to hand, and willing to cooperate the cause of research. The covid -19 pandemic has been taken care of in the collection of information.The study was carried out in the selected area of Amanishah region.

The Groundwater Potential

The below mentioned figure(3) explores the depth of ground water in the studied area and further analyses the potentiality of water in the aquifers of different areas of Amanishah area. The table 2 shows the eight major locations where the trend of lowering of ground water exists.

Figure:3



Ground water Potential: (Source: Scholar)

Table:2

S. No.	Location	Depth of water level		Rate of WL decline (m/year)
		2001	2012	
1	Durgapura	24.11	35.48	2.27
2	Jhotwara	45.90	55.62	1.94
3	MES	38.+77	55.22	3.29
4	Mansarovar	25.25	38.01	2.55
5	Sirsi	42.98	55.51	2.51
6	Surya Nagar	17.46	21.72	0.85
7	Sukhpuria	23.02	27.10	0.82
8	Watika	24.08	36.58	2.52

Source: Central Ground Water Board (2015), District Groundwater Brochure, Jaipur District (Rajasthan)

Urban Impact on Water Resource

Degradation in Water Quality

The quality of surface water has impeded the livability of Jaipur city The main culprit of this issue is the industrial processes working without the administrative consent. The foul smelling of Amanishah nala in addition to its unsightfulness has been ascribed to the untreated industrial discharge of waste water into it. The ever increasing mosquito breeding around the area is held responsible for making the dwellers vulnerable to health risks. The spillage of waste water in consequent upon the blocked drains continuously increase the cost of repairing of surface roads, hence aggravates the burden on exchequer. The heath situation further gets confounded owing to the domestic uses of wastewater and into agriculture. The hotel industry has further aggravated the problem as waste water is let out in a drain connecting to the sewerage network.

Depletion of Groundwater

The rapid urbanization gave unending momentum to the encroachment upon forest lands, agricultural fields, pasturelands, and open wasteland. The open areas of Jaipur city have shrunk due to building of roads, houses, and commercial complexes. The maximum part of the studied area has been termed to the dark zone because of the over-exploitation of groundwater

Degradation in Groundwater Quality

Urbanization and industrialization have had a negative impact on groundwater quality in and around Jaipur. Degradation in groundwater quality is very much linked to the degradation in surface water quality. Groundwater can be easily polluted from waste generated from domestic, industrial, and agricultural sources. Wastewater generation from industry, as well as hotels, can negatively affect groundwater through direct seepage into the aquifer below. Overexploitation of groundwater concentrates inherent salts found in these rock compositions and influences such factors of water quality as total dissolved solids, fluorides, chlorides, etc. The pollution created by nearby industries has had a noticeable effect on the quality of hand pump water in various areas of Jaipur.

Though twenty five ground water samples from the studied area were collected each during pre- as well as post-monsoon seasons during the year 2015 in order to analyse the various physico-chemical and bacteriological parameters. There lies a difference in quality with the depth of water. Moreover this trend is posing an ever increasing heath problem to the dwellers in research area.

Table3: Percentage Distribution of Samples for Various Water Quality Parameters in Groundwater of Metropolitan City of Jaipur.

S.No.	Parameter	Range (mg/L)	Jaipur City
1	TDS	0-500	44(48)
		500-2000	56(52)
		>2000	**-(-)**
2	Alkalinity	0-200	64(76)
		200-600	36(24)
		>600	**-(-)**
3	Hardness	0-300	48(48)
		300-600	28(36)
		>600	**24(16)**
4	Calcium	0-75	44(52)
		75-200	48(44)
		>200	**8(4)**
5	Magnesium	0- 30	40(52)
		30-75	48(40)
		>75	**12(8)**
6	Chloride	0-250	80(88)
		50-1000	20(12)
		>1000	**-(-)**
7	Sulphate	0-200	100(100)
		200-400	-(-)
		>400	**-(-)**
8	Nitrate	0-45	36(44)
		45-100	24(20)
		>100	**40(36)**
9	Fluoride	0-1.0	20(44)
		1.0-1.5	40(48)
		>1.5	**40(8)**

Source: Status of Groundwater Quality in India-Part-2, CPCB, April 2008.

* (Values given in parentheses represent post-monsoon data.)

Table4: Percentage Distribution of Samples for various Metal Ions in Groundwater of Metropolitan City of Jaipur.

S.No.	Parameter	Range (µg/L)	Jaipur City
1	Iron	0-300	20(28)
		300-1000	36(40)
		> 1000	**44(32)**
2	Manganese	0-100	92(96)
		100-300	4(4)
		> 300	**4(-)**
3	Copper	0-50	96(96)
		50-1500	4(4)
		> 1500	**-(-)**
4	Chromium	0-50	100(100)
		> 50	-(-)
5	Lead	0-50	92(80)
		> 50	8(20)
6	Cadmium	0-10	88(100)
		> 10	12(-)
7	Zinc	0-5000	100(100)
		5000-15000	-(-)
		> 15000	**-(-)**

Source: Status of Groundwater Quality in India-Part-2, CPCB, April 2008.

* (Values given in parentheses represent post-monsoon data.)

Results

The pH and conductivity values along with other parameters present in the ground water of metropolitan city of Jaipur are mostly confined within the following range. (Pre and Post monsoon season) Table: 5

Table:5

S.no	Parameters	Pre Monsoon	Post Monsoon
1	pH	5.7 to 8.0	6.9 to 8.0
2	Conductivity	486 to 2300 µS/cm	430 to 2110 µS/cm
3	Calciuum	from 21 to 222	19 to 222 mg/L
4	Sulphate	1 to 155 mg/L	1 to 125 mg/L
5	Fluoride	0.45 to 3.20 mg/L	0.10 to 2.80 mg/L
6	TDS	311 to 1472 mg/L	275 to 1350 mg/L
8	alkalinity	235 to 618 mg/L	208 to 590 mg/L
9	total hardness	105 to 890 mg/L	103 to 783 mg/L

The concentration of sodium in the study area varies from 19 to 222 mg/L during pre-monsoon season and 17 to 160 mg/L during post-monsoon season. The Bureau of Indian Standards has not included sodium in drinking water standards.

The concentration of chloride varies from 4.6 to 432 mg/L during premonsoon season and 3 to 362 mg/L during post-monsoon season. More than 80 per cent of the samples of the metropolitan city fall within the desirable limit of 250 mg/L during both pre- and post-monsoon season (Table 2). No sample of the city exceeds the maximum permissible limit of 1000 mg/L both during pre- and post-monsoon season.

The Nitrate content in drinking water is considered important for its adverse health effects. The occurrence of high levels of nitrate in ground water is a prominent problem in many parts of the country. The nitrate content in the metropolitan city of Jaipur varies from 7.9 to 375 mg/L during pre-monsoon season and 8.8 to 318 mg/L during postmonsoon season. Distribution of nitrate in the ground water indicates that about 40 per cent of the samples fall within the desirable limit of 45 mg/L while about 40 per cent sample exceed the maximum permissible limit of 100 mg/L

Nitrate is effective plant nutrient and moderately toxic. A limit of 45 mg/L has been prescribed by WHO (1996) and BIS (1991) for drinking water supplies. Its concentration above 45 mg/L may prove detriment to human health. In higher concentrations, nitrate may produce a disease known as *methaemoglobinaemia* (blue baby syndrome) which generally affects bottle-fed infants. Repeated heavy doses of nitrates on ingestion may also cause carcinogenic diseases.

The study has clearly indicated that no sample of the study area exceeds the maximum permissible limit for TDS and alkalinity. From the hardness point of view about 20% samples exceed the maximum permissible limit. Chloride and sulphate are within the desirable limit for most of the samples. About 40 per cent samples exceed the maximum permissible limit for nitrate and fluoride during pre-monsoon season. The violation of BIS limit could not be ascertained for sodium and potassium as no permissible limit for these constituents has been prescribed in BIS drinking water specifications.

It is clearly evident from the discussion that the presence of heavy metals has been recorded in many samples and the water quality standards have been violated for iron (44 per cent samples), manganese (4 per cent samples), nickel (32 per cent samples), lead (8 per cent samples) and cadmium (12 per cent samples) during pre-monsoon season. Almost similar trend was observed during post-monsoon season.

Suggestive Measures

1. Removal of total Encroachment to develop the Amanishah Nala
2. Complete ban on disposal of untreated waste in the river
3. Green belt of plantation all along the river
4. Controlled agricultural activity (vegetables /cash crops and flowers) may also be allowed
5. Shifting of tie and die industry from Sanganer to other appropriate sites.
6. Water harvesting to revive and rejuvenate the river system
7. Frequent desiltation of nala be carried out for natural unobstructed flow of drainage water
8. It must be declared 'No Construction Zone' after demarcating its actual width
9. Public places be developed on the nearby spare land.
10. Cycle track and Walk-way use policy should be there

These measures would ensure free flow of clean water in the river with increase green cover and it will also add to scenic beauty, provide fresh air to its citizens and will augment ground water recharge in the region. It is also likely to act as added tourist attraction and vibrant lifeline for Jaipur Region.

Conclusions

The quality of surface water and groundwater of the study area (Amanishah nala and its vicinity) is not safe for drinking as well as irrigation purposes. Moreover, water table has gone down due to overexploitation and the city has been demarcated as dark zone. There are various pollutants like fluoride, nitrate, heavy metals such as cadmium, chromium, lead etc. which are posing serious health hazards. There are another problems like encroachment, illegal construction, illegal settlements, growing agricultural crops and vegetables with untreated water are geat cause of concerns and need special attention. This is good news that the government has taken decision of development and beautification of the nala.

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